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Color Image Segmentation Techniques

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***Abstract*— Image processing is a wide research area in today's life. so many people's are working on this area. Image segmentation is useful in many applications. It can identify the regions of interest in a scene or annotate the data. With the growing research on image segmentation, it has become important to categorise the actual method and provide an overview of the existing segmentation techniques in each category. In this paper, different image segmentation techniques applied on color images are reviewed.**

***Keywords*— Segmentation, Region Based segmentation, Region growing, Thresholding, Edge detection**

I. Introduction

It has many issues to handle in digital image processing including image segmentation, image compression, and image recognition…etc. We will introduce image segmentation here. Image segmentation is the front-stage processing of image compression. In general, we hope that there are three advantages in image segmentation. The first is the speed. When segmenting an image, we do not want speed much time to do it. The second is good shape connectivity of its segmenting result. When segmenting an image, we do not want the result of segmenting shape to be fragmentary. If the result of segmenting shape is fragmentary, we need take many resources to record the boundaries of the over-segment results. It is not we want to get the results. The third is good shape matching. Consequently, it will be reliable. Image segmentation can be classified three categories traditionally including Threshold Technique, Region-Based Image Segmentation, and Edge-Based Image Segmentation.

Researchers or peoples are only interested in certain part of the image for applications. These parts are Foreground and background. It needs to extract and separate them in order to identify and analyze object, on this basis it will be possible to further use for the target. we have introduced "image engineering" concept ",it brings theory ,methods ,algorithms, tools, equipment of image segmentation into an overall framework. Image Engineering is a new subject for research and application of image field it can be divided into three levels: Image processing, image analysis and image understanding.

As shown in Figure 1 Image processing is the transformation between the images and improves the visual effects of image. Image analysis i mainly monitor and measure the interested targets in the image in order to get its objective information as a result build up a description of the image, the key point of the image understanding is further study on the nature of each target and the linkage of each other as well obtain an explanation of objective scenario for original image as result guide and plan to action.

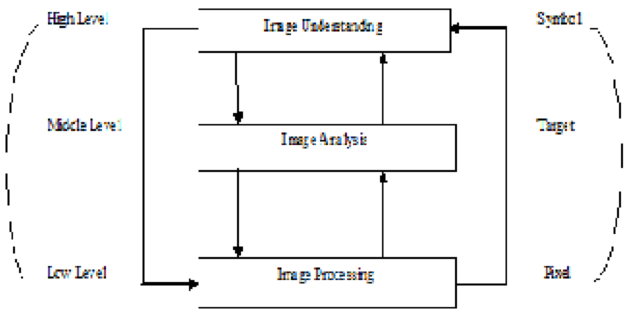

Fig.1 Image Engineering[1]

Image processing is relatively low-level operations; it is mainly operated on the pixel-level. Then image analysis enters the middle-level, it focuses on measuring, expression and description of target. Image Understanding is mainly high-level operation, essentially it focus on the operation and illation of data symbol which abstracts from the description. Image segmentation is a key step from the image processing to image analysis, it occupy an important place. On the one hand, it is the basis of target expression and has important effect on the feature measurement. On the other hand, as the image segmentation, the target expression based on segmentation, the feature extraction and parameter measurement that converts the original image to more abstract and more compact form, it is possible to make high-level image analysis and understanding. For example, satellite image processing in the application of remote sensing; the brain MR image analysis in the applications of medicine; the plates of illegal vehicle region segmentation in the traffic image analysis; the image region of interest extraction in the object-oriented image compression and content-based image retrieval.

II.Image Segmentation Methods

Image segmentation is the process of separating or grouping an image into different parts. These parts normally correspond to something that humans can easily separate and view as individual objects. Computers have no means of intelligently recognizing objects, and so many different methods have been developed in order to segment images. The segmentation process in based on various features found in the image. This might be color information that is used to create histograms, or information about the pixels that indicate edges or boundaries or texture information. The color image segmentation is also widely used in many multimedia applications, for example; in order to effectively scan large numbers of images and video data in digital libraries, they all need to be compiled directory, sorting and storage, the color and texture are two most important features of information retrieval based on its content in the images and video. Therefore, the color and texture segmentation often used for indexing and management of data; another example of multimedia applications is the dissemination of information in the network. Today, a large number of multimedia data streams sent on the Internet, However, due to the bandwidth limitations; we need to compress the data, and therefore it calls for image and video segmentation.

Image segmentation methods are categorized on the basis of two properties discontinuity and similarity. Methods based on discontinuities are called as boundary based methods and methods based on similarity are called Region based methods Segmentation is a process that divides an image into its regions or objects that have similar features or characteristics. Image segmentation methods can be categorized as below

- Region Based Methods
- Thresholding Methods
- Edge Based Methods

A.Region Based Segmentation Methods

Region-based methods mainly on the assumption that the neighboring pixels within one region have similar value. The common procedure is to compare one pixel with its neighbors. If a similarity criterion is satisfied, the pixel can be set belong to the cluster as one or more of its neighbors. The selection of the similarity criterion is significant and the results are influenced by noise in all instances. In this chapter, we discuss four algorithms: the Seeded region growing, the Unseeded region growing, the Region splitting and merging, and the Fast scanning algorithm[2].

1) Seeded Region Growing

The seeded region growing (SRG) algorithm is one of the simplest region-based segmentation methods[2]. performs a segmentation of an image with examine the neighboring pixels of a set of points, known as seed

It points, and determine whether the pixels could be classified to the cluster of seed point or not. The algorithm procedure is as follows:

Step1. We start with a number of seed points which have been clustered into n clusters, called C1, C2, …, Cn. And the positions of initial seed points is set as p1, p2, …, p3.

Step2. To compute the difference of pixel value of the initial seed point pi and its neighboring points, if the difference is smaller than the threshold. we define, the neighboring point could be classified into Ci,where i = 1, 2, …,n.

Step3. Recompute the boundary of Ci and set those boundary points as new seed points pi (s). In addition,the mean pixel values of Ci have to be recomputed, respectively.

Step4. Repeat Step2 and 3 until all pixels in image have been allocated to a suitable cluster.

The threshold is made by user and it usually based on intensity, gray level, or color values. The regions are chosen to be as uniform as possible.

Advantages:

- Each of the segmentation regions of SRG has high color similarity and
- No fragmentary problem.

Disadvantages:

- The initial seed-points problem means the different sets of initial seed points cause different segmentation results. This problem reduces the stability of segmentation results from the same image.
- Time-consuming because SRG requires lots of computation time, and it is the most serious problem of SRG.

2) Unseed Region Growing

The unseeded region growing (URG) algorithm is a derivative of seeded region growing. Their distinction is that no explicit seed selection is necessary. In the segmentation procedure, the seeds could be generated automatically. So this method can perform fully automatic segmentation[2] with the added benefit of robustness from being a region-based segmentation. The steps of URG are as below:

Step1. The process initializes with cluster C1 containing a single image pixel, and the running state of the process is a set of identified clusters, C1, C2, …, Cn.

Step2. We define the set of all unsigned pixels which borders at least one of those clusters.

Step3. To choose a point from cluster. If difference is less than the predefined threshold t, the pixel is clustered to Cj.

Step4. After the pixel has been allocated to the cluster, the mean pixel value of the cluster must be updated.

Step5. Repeate Step2 to 4 until all pixels have been assigned to a cluster.

3) Region Splitting and Merging

The main goal is to distinguish the similarity of the image. It is based on quadtrees, which means each node of trees has four descendants and the root of the tree corresponds to the entire image.Each node represents the subdivision of a node into four descendant nodes. The in-stance is shown in Fig.2. Let R represent the entire image region and decide a predication P. The purpose is that if , we divide the image R into quadrants. If P is FALSE for any quadrant, we subdivide that quadrant into subquadrants, and so on. Until that, for any region R_i, P(R_i)=TRUE. After the process of splitting, merging process is to merge two adjacent regions R_j and R_k if P($R_j \hat{U} R_k$) =TRUE ,

The summarized procedure is described as follows:

Step1. Splitting steps: For any region R_i,which $P(R_i)$=FALSE , we split it into four disjoint quadrants.
Step2. Merging steps: When no further splitting is possible, merge any adjacent regions R_j and R_k for which $P(R_j \hat{U} R_k)$ =TRUE.
Step3. Stop only if no further merging is possible.
Advantages:

- The image can be split according to our demanded resolution because the number of splitting level is determined by us.
- The splitting and the merging criteria should be different

Disadvantages:

- It may produce the blocky segments.

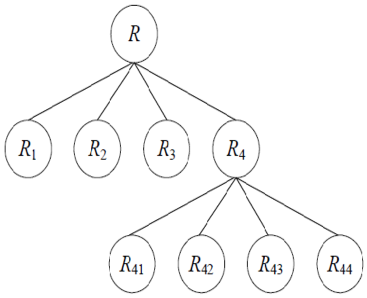

Fig.2 The structure of quadtree, where *R* represents the entire image region[2]

4) Fast Scanning Algorithm

Fast scanning algorithm do not need seed point. The concept of fast scanning algorithm [2] is to scan from the upper-left corner to lower-right corner of the whole image and determine if we can merge the pixel into an existed clustering. The merged criterion is based on our assigned threshold. If the difference between the pixel value and the average pixel value of the adjacent cluster is smaller than the threshold, then this pixel can be merged into the cluster. The threshold usually chooses 45. We describe the steps of the fast scanning algorithm as below:

Step1. Let the upper left pixel as the first cluster. Set the pixel (1, 1) in the image as one cluster C_i and the pixel which we are scanning as C_j. We give an example in Fig. 10 and assume that the threshold is 45 here.

Step2. In the first row, we scan the next pixel (1, 1+1) and determine if it can be merged into the first cluster or become a new cluster according to the threshold. The judgments are in the following, where mean represents the average pixel value of cluster C_i.

- If $|C_j - \text{mean}(C_i)| \leq \text{Theshold}$ then we merge C_j into C_k and recalculate the mean of C_i.
- If $|C_j - \text{mean}(C_i)| \geq \text{Theshold}$ then we set C_j as a new cluster C_i+1.

Step3. Repeat Step 2 until all the pixels in the first row have been scanned.

Step4. To scan the pixel (x+1, 1) in the next row and compare this pixel with the cluster C_u which is in the upside of it. And determine if we can merge the pixel (x+1, 1) into the cluster C_u.

- If $|C_j - \text{mean}(C_u)| \leq \text{Theshold}$ then we merge C_j into C_u and recalculate the mean of C_u.
- If $|C_j - \text{mean}(C_n)| \geq \text{Theshold}$ then we set C_j as a new cluster C_n, where n is the cluster number so far.

Step5. Scan the next pixel (x+1, 1+1) and compare this pixel with the cluster C_u and C_l, which is in the upside of it and in the left side of it, respectively. And decide if we can merge the pixel (x+1, 1+1) into anyone of two cluster.

- if $|C_j - \text{mean}(C_u)| \leq \text{Theshold}$ & $|C_j - \text{mean}(C_n)| \leq \text{Theshold}$,

  (1) We merge C_j into C_u or merge C_j into C_l.

  (2) Merge the cluster C_u and C_l into cluster C_n, where n is the cluster number so far.

  (3) Recompute the mean of Cn.
- If $|C_j - \text{mean}(C_u)| \leq \text{Theshold}$ & $|C_j - \text{mean}(C_l)| > \text{Theshold}$,

  (1) we merge C_j into C_u and recalculate the mean of C_u.
- If $|C_j - \text{mean}(C_u)| > \text{Theshold}$ & $|C_j - \text{mean}(C_l)| \leq \text{Theshold}$,

  (1) we merge C_j into C_l and recalculate the mean of C_l.
- Otherwise, set C_j as a new cluster C_n, where n is the cluster number so far.

Step6. Repeat Step 4 to 5 until all the pixels in the image have been scanned.
Step7. Remove small clusters. If , we remove cluster m and assign the pixels in cluster m into adjacent clusters. the assignment is according to the smallest differences between the pixel and its mean of adjacent clusters.
Advantages:

- It has good shape connectivity.
- The computation time is faster than both region growing algorithm and region splitting and merging algorithm.
- It has good shape matching.

B.Edge Detection

The edge representation of an image significantly reduces the quantity of data to be processed, yet it retains essential information regarding the shapes of objects in the scene. This explanation of an image is easy to incorporate into a large amount of object recognition algorithms used in computer vision along with other image processing applications. The major property of the edge detection technique is its ability to extract the exact edge line with good orientation as well as more literature about edge detection has been available in the past three decades. On the other hand, there is not yet any common performance directory to judge the performance of the edge detection techniques. The performance of an edge detection techniques are always judged personally and separately dependent to its application.

Edge detection is a fundamental tool for image segmentation. Edge detection methods transform original images into edge images benefits from the changes of grey tones in the image. In image processing especially in computer vision, the edge detection treats the localization of important variations of a gray level image and the detection of the physical and geometrical properties of objects of the scene. It is a fundamental process detects and outlines of an object and boundaries among objects and the background in the image. Edge detection is the most familiar approach for detecting significant discontinuities in intensity values.

Edges are local changes in the image intensity. Edges typically occur on the boundary between two regions. The main features can be extracted from the edges of an image. Edge detection has major feature for image analysis. These features are used by advanced computer vision algorithms. Edge detection is used for object detection which serves various applications like medical image processing, biometrics etc. Edge detection is an active area of research as it facilitates higher level image analysis. There are three different types of discontinuities in the grey level like point, line and edges. Spatial masks can be used to detect all the three types of discontinuities in an image.

There are many edge detection techniques in the literature for image segmentation. The most commonly used discontinuity based edge detection techniques are reviewed. Those techniques are Roberts edge detection, Sobel Edge Detection, Prewitt edge detection, Kirsh edge detection, Robinson edge detection, Marr-Hildreth edge detection, LoG edge detection and Canny Edge Detection.

B.Edge Detection Techniques

1) Roberts Edge Detection

The Roberts edge detection is introduced by Lawrence Roberts (1965). It performs a simple, quick to compute, 2-D spatial gradient measurement on an image. This method emphasizes regions of high spatial frequency which often correspond to edges. The input to the operator is a grayscale image the same as to the output is the most common usage for this technique. Pixel values in every point in the output represent the estimated complete magnitude of the spatial gradient of the input image at that point[3].

2) Sobel Edge Detection

The Sobel edge detection method is introduced by Sobel in performs a 2-D spatial gradient quantity on an image and so highlights regions of high spatial frequency that correspond to edges. In general it is used to find the estimated absolute gradient magnitude at each point in n input grayscale image. In conjecture at least the operator consists of a pair of 3x3 complication kernels as given away in under table. One kernel is simply the other rotated by 90o. This is very alike to the Roberts Cross operator.

3) Prewitt Edge Detection

The Prewitt edge detection is proposed by Prewitt in 1970[3]. To estimate the magnitude and orientation of an edge Prewitt is a correct way. Even though different gradient edge detection wants a quite time consuming calculation to estimate the direction from the magnitudes in the x and y-directions, the compass edge detection obtains the direction directly from the kernel with the highest response. It is limited to 8 possible directions; however knowledge shows that most direct direction estimates are not much more perfect. This gradient based edge detector is estimated in the 3x3 neighborhood for eight directions. All the eight convolution masks are calculated. One complication mask is then selected, namely with the purpose of the largest module. Prewitt detection is slightly simpler to implement computationally than the Sobel detection, but it tends to produce somewhat noisier results.

4) Kirsch Edge detection

Kirsch edge detection is introduced by Kirsch (1971). The masks of this Kirsch technique are defined by considering a single mask and rotating it to eight main compass directions: North, Northwest, West, Southwest, South, Southeast, East and Northeast. The masks are distinct as follows:

The edge magnitude is defined as the maximum value found by convolution of each mask with the image. The direction is defined by mask that produces the maximum magnitude. Example, mask k0 corresponds to a vertical edge, while mask k5 corresponds to a diagonal edge. Notice that the last four masks are actually the same as the first four, but flipped about a central axis.

5) Robinson Edge detection

The Robinson method (Robinson 1977) is similar to Kirsch masks but is easier to implement because they rely only on coefficients of 0, 1 and 2. The masks are symmetrical about their directional axis, the axis with the zeros. One need only to compute the result on four masks and the result from other four can be obtained by negating the result from the first four. The masks are as follows:

The magnitude of the gradient is the maximum value gained from applying all eight masks to the pixel neighborhood, and the angle of the gradient can be approximated as the angle of the line of zeroes in the mask yielding the maximum response.

6) Marr-Hildreth Edge Detection

there are well-built and fast variations in image brightness. It is a easy and it operates by convolving the image with the LoG function, or, as a quick approximation by DoGs. Subsequently the zero-crossings are discovered in the filtered result to find the edges. The LoG method is sometimes as well referred to as the Mexican hat wavelet due to its image shape while turned up-side-down. Algorithm for the Marr-Hildreth edge detector is:

- Smooth the image using a Gaussian
- Apply a two-dimensional Laplacian to the smoothed image (often the first two steps are combined into a single operation)
- Loop through the result and look for sign changes. If there is a sign change plus the slope across the sign change is greater than some threshold, mark as an edge.
- To get better results it is possible to run the result of the Laplacian through a hysteresis alike to Canny's edge detection although this is not how the edge detector was firstly implemented.

7) Canny Edge Detection

In industry, the Canny edge detection technique is one of the standard edge detection techniques[3]. It was first created by John Canny for his Master's thesis at MIT in 1983, and still outperforms many of the newer algorithms that have been developed. To find edges by separating noise from the image before find edges of image the Canny is a very important method. Canny method is a better method without disturbing the features of the edges in the image afterwards it applying the tendency to find the edges and the serious value for threshold. The algorithmic steps are as follows:

- Convolve image with a Gaussian function to get smooth image.
- Apply first difference gradient operator to compute edge strength then edge magnitude and direction are obtain as before.
- Apply non-maximal or critical suppression to the gradient magnitude.
- Apply threshold to the non-maximal suppression image.

Unlike Roberts and Sobel, the Canny operation is not very susceptible to noise. If the Canny detector worked well it would be superior.

C.Thresholding

Threshold techniques can be categorized into two classes: global threshold and local (adaptive) threshold [4]. In the global threshold, a single threshold value is used in the whole image. In the local threshold, a threshold value is assigned to each pixel to determine whether it belongs to the foreground or the background pixel using local information around the pixel. Because of the advantage of simple and easy implementation, the global threshold has been a popular technique in many years. Threshold is one of the widely methods used for image segmentation. It is useful in discriminating foreground from the background. By selecting an adequate threshold value T, the gray level image can be converted to binary image. The binary image should contain all of the essential information about the position and shape of the objects of interest (foreground). The advantage of obtaining first a binary image is that it reduces the complexity of the data and simplifies the process of recognition and classification.

Thresholding Techniques:

Threshold technique is one of the important techniques in image segmentation. This technique can be expressed as: T=T[x, y, p(x, y), f(x, y]

Where: T is the threshold value. x, y are the coordinates of the threshold value point.

p(x,y) ,f(x,y) are points the gray level image pixels.

Threshold image g(x,y) can be define:

$$g(x,y) = \begin{cases} 1 \text{ if } f(x,y) > T \\ 0 \text{ if } f(x,y) \le T \end{cases}$$

……….(1)

1) Mean Technique

This technique used the mean value of the pixels as the threshold value and works well in strict cases of the images that have approximately half to the pixels belonging to the objects and the other half to background. This technique rarely happens.

2) P-Tile Technique

The p-tile technique uses knowledge about the area size of the desired object to the threshold an image.

The P-tile method is one of the earliest threshold methods based on the gray level histogram [4]. It assumes the objects in an image are brighter than the background, and occupy a fixed percentage of the picture area. This fixed percentage of picture area is also known as P%. The threshold is defined as the gray level that mostly corresponds to mapping at least P% of the gray level into the object. Let n be the maximum gray level value, H (i) be the histogram of image (i = 0. n), and P be the object area ratio. The algorithm of the P tile method is as follows:

S=sum (H(i)) …….(2)
Let f=s
For k=1 to n
f=f-H (k-1)
If (f/t) < p then stop
T=k

Where: S total area of image
f is the initialize all area as object area
T is the final threshold value

This method is simple and suitable for all sizes of objects.

Advantages:

- It yields good anti-noise capabilities.

Disadvantage:

- it is obviously not applicable if the object area ratio is unknown or varies from picture to picture.

3) Histogram Dependent Technique (HDT)

The histogram based techniques is dependent on the success of the estimating the threshold value that separates the two homogonous region of the object and background of an image. This required that, the image formation be of two homogonous and will-separated regions and there exists a threshold value that separated these regions. The (HDT) is suitable for image with large homogonous and will separate regions where all area of the objects and background are homogonous and except the area between the objects and background.

4) EMT Technique

The threshold image by using edge maximization technique (EMT) is used when there are more than one homogenous region in image or where there is a change on illumination between the object and its background. In this case portion of the object may be merged with the background or portions of the background may as an object. To this reason any of the automatic threshold selection techniques performance becomes much better in images with large homogenous and well separated regions [4]. This techniques segmentation depend on the research about the maximum edge threshold in the image to start segmentation that image with help the edge detection techniques operators.

5) Visual Technique

These techniques improve people's ability to accurately search for target items. These techniques are similar to one another P-Tile technique in that they all use the component segments of original images in novel ways to improve visual search performance but it is different from p-tile don't active when the noise is present in the image

Applications

- In Medical Images:
  - Locate tumors and other pathologies
  - Measure tissue volumes
  - Computer-guided surgery
  - Diagnosis
  - Treatment planning
  - Study of anatomical structure and Finding Veins
- In Satellite and Aerial Images:
  - Finding Targets
- In Surveillance System:
  - Finding Peoples
  - Summarizing Videos

Conclusion

- Region based methods are fast, simple, completeness, connectedness, disjointness, segmentability, satisfability.
- Thresholding is very simple method of segmentation.
- In thresholding HDT and EMT are the best techniques.
- Edge detection methods transform original images into edge images benefits from the changes of grey tones in the image.
- In some applications region based techniques are better than edge based techniques in noisy images where the edges are difficult to find out.
- From Above Points Segmentation having
  - Good Speed,
  - Good Shape connectivity and
  - Good Shape Matching

References

[1]. Nikita Sharma, Mahendra Mishra, Manish Shrivastava,"*Color Image Segmentation Techniques, and Issues:An Approach*"International Journal of Scientific & Technology Research Volume Issue 4, May 2012.

[2]. Yu-Hsiang Wang," *Tutorial: Image Segmentation*"

[3]. Muthukrishnan.R and M.Radha," *edge detection techniques for image segmentation*", International Journal of Computer Science & Information Technology (IJCSIT) Vol 3, No 6, Dec 2011.

[4]. Salem Saleh Al-amri, N.V. Kalyankar and Khamitkar S.D," Image *Segmentation by Using Thershod Techniques*", JOURNAL OF COMPUTING, VOLUME 2, ISSUE 5, MAY 2010, ISSN 2151-9617